THE TEACHERS COLLEGE JOURNAL

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A General Shop, Its Equipment And A Suggested Curriculum For The Smaller High Schools

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I. Introduction

Although that phase of industrial arts which is known as the general shop had its beginning about twenty years ago, it has developed rather slowly. This is due largely to a lack of teacher education courses and, consequently, a lack of trained teachers. It may be said, perhaps, that not until the present time is it getting well under way; therefore, this paper may be of interest to those who view the work from the side-lines as well as those industrial arts teachers who may be interested in supervising it or in teaching it.

It should not be construed that this is the last word, but rather it is a humble attempt to set down some fundamental principles that may help in organizing courses, and to clear up some mystifying conceptions or ideas about the work.

The subject is a large one and a great deal of research and experimentation is still required. Professional organizations of teachers may help by including in their programs opportunities for discussing the subject. Teacher education institutions may help by collecting references and lists of references on the subject. Of greatest value, however, should be the contributions that individual teachers may make by divulging their daily classroom experiences in teaching the work.

The material presented in this paper includes work in four activities which would comprise a year's work in the junior high school; thus allowing nine weeks to each activity.

In view of the fact that the units of work in some schools are organized on a semester basis, it was deemed advisable to include enough work in each unit for an entire semester. Thus teachers will find it necessary to make readjustments in the material presented, in accordance with the amount of time available.

II. The General Shop Idea

A. Origin and development

The junior high school movement brought about a great many changes in the organization and content of the work for grades seven, eight, and nine. Teachers of each subject were forced to reorganize the content of their subjects in order to "fit into" or be in accord with the aims and objectives of the new type of school. The general shop is the answer of teachers of industrial arts to the demands of the junior high school.

It should be of interest to know of the contributions made by the industrial arts to the development of this new school. William E. Roberts said, "Not the least significant feature in the history of the junior high school is that it must acknowledge a large debt to experiments in which the manual arts and their interpretation in pedagogical terms have played an important part."[1]

In spite of the recognized importance of the general shop and all the study that has been made there are still many factors relating to its success that seem to be confusing. It has already passed through three or four rather distinct stages of development.

Beyond a doubt, it has passed far beyond the experimental stage but its wide acceptance and rapid growth have, in many respects, been a handicap.

Some of the problems relating to the general shop that have been difficult to answer might well be mentioned here, although no effort will be made to mention all of them, nor to give them in any order of importance.

1. The question of terminology has created considerable confusion.

2. For a time there was a great deal of controversy over objectives, but this difficulty has gradually been eliminated to a very large extent through some general agreement regarding major objectives.

3. The plan of organization has always been a controversial question. Should the work be organized on a project basis or an activity basis?

4. The question of related work; how much and how should it be presented.

5. The problem of equipment has not been an easy one to handle.

6. The qualifications a general shop teacher should have are now rather generally known, but it is still difficult to secure good teachers of general shop.

B. Types of organization

1. The Ettinger Plan

In this plan the individual pupil is routed through a series of specialized shops for periods varying, as a rule, from six to twelve weeks.

2. The Bonser Plan (Russel-Bonser) (Multiple Activity Shop)

In this plan the pupil is given a variety of experiences, with industrial materials, tools, and processes in a general industrial shop.

3. The Gary Plan

In this plan the pupil gets his industrial experiences working on productive work, under the direction of an experienced tradesman.

4. The Pittsburg Plan

In this plan the pupil spends the first year in a general shop (Bonser Plan), the second year in a series of special shops (Ettinger Plan), and the third year spends all of the shop time in one special shop which he has chosen, "pre" to entrance upon the vocation.

5. The Laboratory Plan

In this plan the interest of the pupil is almost the only guide in determining the nature of the work to be done. Pupils work on projects which they select, and emphasis is placed on the organization and planning of the work. A wide variety of industrial experiences is provided without resorting to trade classification in the organization of the work.

Each of these plans has certain advantages and disadvantages which must be carefully considered in organizing a general shop. It is not necessary, however, to adopt any one type exclusively since features of each type might be combined in various ways in order to secure certain advantages that would not be possible if any one type of plan were adopted. Many things must be considered in determining the plan of organization for the efficient operation of a general shop.

[1]William E. Roberts, *Manual Arts in the Junior High School*, (Washington, D. C.: U. S. Bureau of Education, Bulletin No. 11, 1924), p. 14.

C. The advantages of the general shop plan

1. Pupils can have an experience with a greater variety of materials.

2. Makes possible a contact with a greater variety of tools and tool processes.

3. Makes a provision for taking care of individual differences.

4. Makes possible a closer connection between the school and home (chiefly through work in home mechanics).

5. Participation in several activities requires a wider range of thinking and thus is more educational.

6. Provides better opportunity for pupils to discover their own interests, aptitudes, and capacities.

7. No loss of time in the completion of a project in more than one material.

8. It makes possible the development of initiative on the part of the pupil, or stimulates individual thinking on the part of the pupil.

9. It makes for economy in both equipment and teaching force.

10. It makes possible the more extensive use of the project method of teaching.

11. It eliminates waste of time caused by a duplication of processes in the one industry shop.

12. It enables a pupil to learn to do a great many things which all men should know and be able to do without respect to their vocations.

D. Disadvantages of the general shop

1. Well trained instructors are not as yet available for teaching in the general shop.

2. Class teaching with careful demonstration and discussion is possible only when all are doing similar kinds of work.

3. Proper teaching cannot be done in a general shop without a great number of instruction sheets to explain the work. The teacher has little time to make such teaching helps with drawings, directions, etc., and have duplicate copies made.

4. The equipment and supplies are more difficult to take care of than in the one industry shop.

5. The general shop, because of the diversified character of the work done, tends to look like a "junk shop," while the one industry shop can be kept in better order.

6. It is difficult to organize the work in order to keep everyone busy in a general shop.

7. The instruction given by the teacher, when spread out over so many groups, can only be fragmentary.

8. It is practically impossible for any man to become an expert in several unrelated industrial activities; therefore, strong teachers cannot easily be prepared for a general shop.

9. Discipline is made more difficult.

E. Wrong conceptions of the general shop

Much confusion has resulted from the tendency on the part of many teachers to associate the general shop idea with a certain number of industrial activities. In other words, the objective sought through the establishment of a general shop would best be attained by continually adding other activities. For example, if a general shop had been started with four activities, then the objective could be better attained by the addition of two or three or even four other activities.

It should be understood that there is no definite relation between the number of activities offered and the objective to be attained in order to have a general shop.

The location of the activities as to their grouping or arrangement in one room or in adjacent rooms is a matter that seems to confuse a number of teachers.

The importance of this feature does not depend on whether the equipment is located in one room or not, but rather on the adequacy of the equipment and the convenience of its arrangement.

The shop might be more conveniently arranged in many respects if certain types of work were segregated from the remainder of the activities. Drawing, for example, could be carried on better if it were separated from the noise and dirt of the foundry, concrete, and forge units.

The fact that some activities are separated from the rest of the shop does not prevent the shop from being classified as a general shop.

In a few schools it has seemed desirable to provide very large shops with equipment

for four or more activities to accommodate sixty to seventy-five pupils. This situation has again raised the question concerning the classification of a shop of this kind. There is nothing, however, in a situation of this type that needs to be confusing. If the objective can best be attained by this plan, the fact that two teachers are present at the same time and are jointly responsible for the class does not prevent this shop from being classified as a general shop.

There has been a strong tendency in a majority of good general shops to use various types of instruction sheets as aids in increasing the efficiency of the instructor. This has raised the question among a few teachers regarding the extent to which instruction sheets may be necessary in a general shop.

The writers would like to state emphatically that the mere use of instruction sheets, regardless of how good they may be, will not make a general shop out of a unit shop. Neither will the classification of a general shop be changed if the teacher ceases to use instruction sheets. Instruction sheets are merely instructional aids and have no relation whatever to the classification of a shop.

A few general shop teachers hesitate about doing work outside of the shop, such as building a garage, or putting in a concrete walk, or building an ash pit, because they feel such work is inconsistent with the general shop idea. The writers feel that it is a regrettable fact that more teachers do not interest themselves and their classes in work of this type.

The fact that a teacher does work "on the job" has no relation to the classification of the shop. It merely indicates that a higher type of teacher is in charge of the work and is giving his classes an experience that, unfortunately, only a very few teachers are providing.

Another confusing factor has been the time devoted to the various activities. A few teachers seem to think that certain standards exist which must be maintained in order to be classified as a general shop. Others are of the opinion that each activity must have exactly the same amount of time.

It may be stated that neither of these conceptions is correct. The amount of time allotted to each activity of course can be either too long or too short to be consistent with the aims and objectives of the general shop.

There seems to be a rather strong tendency toward offering three or four activities a year, thus providing an experience of nine to twelve weeks in each activity.

The only reason the same amount of time is devoted to each activity is that this plan simplifies the organization of the work. Few teachers will doubt the fact that more progress can be made in certain industrial activities in nine weeks time, for example, than could be made in certain other activities in the same length of time, however, it would greatly complicate the organization of the year's work if the work in one unit covered a period of nine weeks while for another unit it extended over a period of twelve weeks.

F. Selecting activities for a general shop

Another feature of the general shop that requires very careful attention is the selection of the industrial activities that are to be included. There are several factors that should be considered in selecting the activities for a general shop, but the relative importance of each of these factors will vary with each situation. Space will not permit an evaluation of the factors that should be considered, but the following list includes the most important of these items:[2]

1. Community survey
2. Nature of the school system
3. Floor space
4. Equipment
5. Amount of money available
6. Conference with community leaders
7. Conference with school officials
8. Qualifications of the teacher
9. Number of pupils to be accommodated
10. Grades to be accommodated
11. Curriculum evaluation
12. Possibilities of securing assistance from local organizations and industries

[2]Sylvan A. Yager, "Selecting General-Shop Courses," *Industrial Arts and Vocational Education*, XXIV, (December, 1935), 359.

13. Program of vocational education
14. Combination of activities
15. Aims and objectives of the course
16. Occupational evaluation
17. Elements of danger involved
18. Boy interest evaluation
19. Activity evaluation
20. Availability of public utilities service
21. Location of room to be used
22. Relation to industrial arts work previously offered
23. Types or classification of general shops

III. Objectives of Industrial Arts

A few years ago the topic of objectives of industrial arts became of first-rank importance at conventions and other meetings of industrial arts groups. As a result of this agitation several commendable and scientific studies have been made in order to determine how well leading educators in the field of industrial arts are in agreement on the subject of objectives for industrial arts.

A commendable piece of work in the way of collecting and organizing the objectives was completed in 1933 by John J. Voth and William L. Hunter of Ames, Iowa.[3]

No studies have been made which reveal the sentiments of industrial arts educators toward the Seven Cardinal Principles of Education. The authors feel safe, however, in stating that industrial arts educators have accepted whole-heartedly these principles and that they are in accord with the idea that it is the duty of every teacher of each subject to endeavor to meet these principles in so far as it is possible for them to do so.

IV. Shop Plans and Equipment for Industrial Arts Subjects

The term "shop plans" means those features of a school shop that are built into it when it is constructed, as well as the location of the shop in the building. Equipment refers to the movable pieces of apparatus such as machines, benches, cabinets, etc.

Perhaps the most important feature of a school shop is light. Since practically all industrial arts work involves the use of measuring tools and close observation, an ample supply of light is highly important. The windows should be forty-eight inches wide and extend to within six inches of the ceiling. The bottoms of the windows, however, should be at least four feet from the floor in order that work benches may be set in front of them and that work may be done on the benches without danger of breaking the windows by flying pieces of the material that is being worked upon. Most of the bright sunlight comes in through the upper one-third of the windows. If this is glazed with a ribbed glass, window shades will not be needed because ribbed glass shuts out the bright rays of the sun.

Shades are a nuisance; they soon become unsightly and costly and should be omitted if possible. If it is necessary to use them, then ecru or light cream colored twilling or shirting is better than green or black.

If artificial lighting is needed, the semi-indirect electric light is perhaps the best. It consists of a bowl in which the light bulb is fixed. The bowl reflects light upward and since it is translucent, some light shines through, causing shadows that are restful to the eyes. In the case of some machines, it is well to have a movable independent light at each machine. Outlets should be placed at convenient spots in each shop so that lights as well as electrically driven portable machines may be used wherever needed.

The room must be of ample size in order to lessen the danger of accidents. In a pamphlet by Samuel A. Challman[4] are found minimum standards of room sizes for shop subjects as fixed by New York, Michigan, Minnesota, and Pennsylvania. Pennsylvania has fixed for shops carrying not more than five activities in one shop a minimum of 1080 square feet.

The floors should be of a hard wood, matched, and well laid. Wood floors are resilient and, therefore, do not tire the feet so readily. Also tools and material that

[3]John J. Voth and William L. Hunter, *Objectives of Industrial Arts Education*, (Ames, Iowa: Industrial Arts Department, Iowa State College, 1933).

[4]Samuel A. Challman, *Rooms and Equipment for Industrial Arts*, (Milwaukee: The Bruce Publishing Company).

TABLE I

GENERAL OBJECTIVES OF INDUSTRIAL ARTS AS APPEARED IN PRINT SINCE 1930

Objectives	Times Mentioned	Lists Reviewed	Per Cent
Manual abilities and skills	10	16	62
Knowledge of materials used in industry	10	16	62
Knowledge of occupational opportunities	9	16	56
Knowledge of industrial products	8	16	50
Knowledge of industrial processes	8	16	50
Knowledge of tools used	7	16	43
Interest in avocational and leisure time activities	7	16	43
Appreciation of various industries	7	16	43
Prepare students to fill places in life and society for which they are best suited	6	16	37
Problem solving	5	16	31
Exploration of individual inclinations, interests, and abilities	5	16	31
A wholesome respect for manual labor	5	16	31
Develop initiative and give confidence in ability to do things	4	16	25
Instil lofty ideals and worthy attitudes	3	16	18
Creative expression	2	16	12
Related information	2	16	12
Develop leadership and character	2	16	12
Retain or arouse interest in school life	1	16	6
Develop safety consciousness	1	16	6
Develop leadership and character	1	16	6

TABLE II

OBJECTIVES OF INDUSTRIAL ARTS EDUCATION IN THE JUNIOR HIGH SCHOOL

Objectives	Times Mentioned	Lists Reviewed	Per Cent
Develop skill in workmanship	7	8	87
Develop acquaintance with materials and processes of industry	4	8	50
Reveal to pupils their interests and aptitudes	4	8	50
Development of vocational, civic, avocational and moral efficiency	3	8	37
Develop appreciation of good workmanship	2	8	25
Give all-around training	2	8	25
Develop resourcefulness	2	8	25
Develop creativeness	2	8	25
Educational guidance	2	8	25
Knowledge of constructive principles	2	8	25
Instil desirable character traits	2	8	25
Instil cooperation	2	8	25
Develop consumer knowledges	2	8	25
Occupational information	2	8	25
Related information	2	8	25
Develop self-confidence	1	8	12
Develop inventiveness	1	8	12
Develop skills in home maintenance	1	8	12
Opportunity for growth through manipulative activities	1	8	12
Develop interests and aptitudes	1	8	12
Instil a respect for property	1	8	12
Instil a respect for safety of others	1	8	12
Develop thrift	1	8	12
Retention in school	1	8	12

happen to drop on the floor are not so apt to be broken or damaged. One disadvantage of wood floors is that they become slick. Rubber mats, therefore, should be fastened to the floor around the machines in order to prevent accidents. For some shops other factors make the concrete floors more desirable. The following shops may be included in this group: auto mechanics, forging, foundry practice, concrete work, and farm mechanics. The concrete floor should never be adopted if wood will do. The treated wood paving block floor has proved unsatisfactory. A non-slip alundum aggregate for concrete floors is now being used extensively.

Blank wall space is very desirable because it provides a place to hang illustrative material from industrial concerns, bulletin boards, exhibit boards, and tool boards. The doors should be of ample size to permit installing large pieces of equipment and removing large pieces of work. In all cases future developments should be considered and possible room for expansion provided.

The location of rooms is so closely related to this subject that a few suggestions on this point must be made. Drawing rooms should not be placed where vibrations resulting from machinery or heavy traffic will cause trembling. Forge shops, foundries, and auto mechanics shops must be so located that access may be had to a chimney in order to exhaust smoke and gases. All shops should be approachable by trucks in order that bringing in supplies and equipment and removing finished products may be done without disturbing the work of other teachers or mutilating the building. The practice of placing classrooms and shops in the basement is not to be tolerated. All the arguments against placing the former in the basement apply with equal force to the latter. Closets for storing supplies, extra tools, and repair parts may be placed in such parts of the building where the light is poor. Artificial light will do for this purpose.

There is an endless amount of material available on equipment for all types of shop work. The importance of this phase of shop planning is emphasized by Samuel J. Vaughn and Arthur B. Mays.[5] The authors enumerate eight factors as follows: "(1) proper location of work benches and machines with reference to light, (2) proper spacing of benches, machines, and other bulky equipment, (3) width and location of aisles, (4) open spaces for assembling of projects and handling of material, (5) location of demonstration facilities, (6) location of tool room, supply rooms, and wash room, (7) placing of general tools and extra machine parts, and (8) locker arrangement."

In placing woodworking benches, they state, ".. . . and generally in the case of hand tool work, the desirable arrangement is that in which the light comes from the front and left side of the worker. This avoids annoying shadows cast by the worker's body and by his hands and the tools in his hands. . . . . When placing machines of such shape that the upper part of the machine itself may cast a shadow on the place where the tool enters the work, as in the case of the mortising machine, verticle drill, etc., it is well to arrange for the strongest light to come from one side of the operator. If possible, the stronger light should come from the side on which the most used guage or adjusting device is placed on the machine. In the case of the lathe, it is better to have the strong lights to the right and in front of the operator . The right hand light is preferable because of the large amount of face plate work done on the lathe. Blackboards, wall tool panels, key boards, bulletin boards, drawings, etc., should not be placed on a wall in which there are windows. In general, the rule is to place equipment so that the light falls clearly upon the point where work is being performed by a tool and where the result of the tool work can easily be seen at all times by the worker. If this general rule is observed, much unnecessary eye strain and many accidents will be avoided."

The demonstration is an important phase of industrial arts work and provision should be made to do this efficiently. Demonstrating the operation of a machine must be done, of necessity, at the machine and the pupils must arrange themselves

[5]Samuel J. Vaughn and Arthur B. Mays, *Content and Methods of the Industrial Arts*, (New York: The Century Company, 1924), pp. 340-41-42-43-45.

around the machine as advantageously as possible. In such subjects as woodwork, forging, foundry practice, electricity, etc., space should be reserved for a demonstration bench or anvil as the case may be. Seats for the pupils should be placed facing the bench or anvil and a blackboard at the rear of the demonstrator.

A separate room for demonstrating is desirable. The room may also be used for a library and reading room. If necessary the partition between it and the shop may be of glass, thus enabling the instructor to see what is going on in the shop while he is demonstrating.

Closets are desirable in which to store supplies and extra parts for machines and tools. In order to work to advantage in shops, it is necessary to protect clothing from becoming soiled. Coats should be removed and overalls or aprons put on. This makes it necessary to provide a place to store this apparel. The most logical place, it seems, is in a wash room. The wash room provides a convenient place for the regular toilet equipment to which may be added lavatories, showers, a medicine cabinet, and steel lockers for clothing. Although some object to combining all these facilities in one room because it gives boys an opportunity to commit nuisances, still the advantages of this arrangement eclipse the disadvantages. If the wash room is finished and furnished and kept in a neat and satisfactory manner it will curb the committing of nuisances.

A separate room for putting lacquer, varnish, and other finishing material on completed projects is most essential. The dust particles with which the air of shops is filled makes it impossible to finish work satisfactorily in the shop. This room must be made as nearly fireproof as possible. Metal lockers should be provided in which to store finishing materials. Also metal rubbish cans with air-tight covers in which to deposit soiled waste and cloths.

A study made in Tulsa, Oklahoma[6] reveals that many teachers favor:

1. General tool racks in the shop rather than a separate room.
2. A separate room for storing supplies.
3. Locked cupboards or cabinets within each shop, with one set of shelves or pigeonholes closed by one large door for each class period.
4. Wash-sinks within each shop, with at least three outlets, accommodating six boys at once rather than a separate wash room sufficient to accommodate the maximum capacity of the building.
5. A drinking fountain in each shop.
6. A separate room for finishing.
7. A table or deck space within each shop with reference books and magazines.
8. Separate assembly-room, or lecture room, equipped with desks, tables, or tablet-arm-chairs for shop talks and class demonstrations.
9. Individual student lockers for hats, coats, books, shop aprons, etc., in separate lockerroom or in corridor, in the shop building (in lieu of any other individual locker in some other part of the school).
10. Glass-front wall-cabinet or cupboard, for display of shop drawing, instruction sheets, and instructor's demonstration pieces within each shop.

Small tools may be divided into three groups: those that are used by all the students most frequently, those that are used by all occasionally, and those that are used only on special work. Each pupil should be provided with a set of those tools that he uses most frequently. They should be kept in locked cabinets or drawers. Each tool must be marked with a number corresponding with the number placed upon the drawer in which it belongs. Each boy is then held responsible for the tools assigned to him.

The tools that are used by all occasionally may be kept in a tool rack or on a wall board. The second method is the better of the two, perhaps. An outline of the tool should be painted upon the board on the spot covered by the tool. This aids pupils in finding the place for each tool and also aids the instructor in checking up to see that all tools have been returned to their places.

[6]W. T. Bawden, "A Cooperative Study of Plans for New Shops," *The Industrial Education Magazine*, XXIX (April, 1928), 354-55.

In the case of small tools like drills, reamers, taps, threading dies, wood bits, etc., a checking system should be used. A good system is to assign each student certain periods in the term during which he must serve as tool keeper. A special printed form should be provided on which the tool keeper writes the name of the pupil and the name of the tool he borrowed. At the end of the period he must see that all tools are returned.

The tools that are used on special work only should be kept locked up by the instructor in a cabinet behind glass doors. Cabinets are needed to store unfinished projects. A good cabinet is one containing pigeon holes for each student and closed by one large door to which the instructor only has the key.

A good scheme for arranging equipment is the following: Draw a floor plan of the room to some convenient scale. Indicate all the windows, doors, and built-in equipment. Then draw on a separate piece of paper the floor plans of each piece of equipment it is desired to place in the room to the same scale that the room floor plan was drawn. Next cut out the floor plan of each machine. These floor plans may then be placed upon the room floor plan and moved about until a suitable arrangement is secured.

The equipment should be arranged so that as the pupils enter the room they will follow a direct course through the shop to their respective places. It should not be necessary for them to cross and recross the shop in order to get the tools and materials needed.

If the individual electric motor drive system for driving the machines is to be employed, this arranging should be done before the wires are laid in order that they may be placed to suit the arrangement of machines.

In determining the equipment and supplies to buy for any one activity the following method of procedure should be followed. First, decide what the purpose of the work shall be. This will determine the course of study, which should be outlined next, including the projects to be made. The projects to be made together with the number of students enrolled will then determine the kind and quantity of equipment and supplies needed.

It can be readily understood that lists of equipment for different shops serve only as suggestions. Each situation must be met in its own way. Many such lists are available and references to them are given as well as to floor plans of shops.

Bruces' School Shop Annual, 1931, contains elaborately worked out lists of equipment, supplies, and floor plans for elementary, junior high, senior high, technical high, full-time vocational, and part-time vocational schools. It also contains the cuts of machines together with descriptions and specifications of them and the names and addresses of the manufacturers. They are listed for woodwork, metalwork, drafting, electricity, sheet-metal, printing, automotive, general shop, and farm shops.

Volumes XXVII, XXVIII, and XXIX of the *Industrial Education Magazine* contain lists of equipment and floor plans for many activities. These lists are elaborate and general.

In *Content and Method of Industrial Arts* by Samuel J. Vaughn and Arthur B. Mays lists of equipment and floor plans for many the underlying principles for selecting equipment. These lists include the following activities: woodwork, printing, machine shop, sheet-metal, general shop, plumbing, and electricity.

In this paper lists of recommended equipment and supplies are included under the organization of each activity.

V. The Teacher

The general shop teacher should be as well trained as any teacher in the school system. Since one of the important aims of the general shop is guidance, both educational and vocational, the teacher needs to be trained in the social sciences. He needs to be able to point out the advantages and disadvantages of working as an employee in the different shop activities that he teaches as well as other activities in which his pupils may become interested. He needs to know the qualifications required to become successful as a worker in them.

The general shop teacher needs to be trained in psychology, in physical education, and in hygiene. He needs to be able to

recognize the physical and mental traits of his pupils.

The teaching of related subject matter is being stressed very strongly today. The teacher needs to be well grounded in mathematics, physics, chemistry, English, and graphic and plastic arts.

The general shop teacher need not be so well trained in the shop subjects he is teaching as is the teacher of vocational education. One course in each activity is usually sufficient.

The general shop teacher should cultivate refinement and culture in actions and tastes; it will add more to the success of his work.

To acquire all of these qualifications requires years of preparation and application. The opportunities to secure them, however, are plentiful today. Practically all teacher education institutions now offer summer courses. The general shop teacher should not terminate his training until he has secured at least a master's degree.

VI. Organization of Work in Mechanical Drawing

A. Aims

1. To teach how to read and write the language of the industries.
2. To understand the importance of mechanical drawing as a medium of expression, especially as it relates to our everyday lives.
3. To develop and strengthen the power of imagination and visualization.
4. To aid in discovering and developing special interests, abilities, and aptitudes.
5. To develop habits of neatness, accuracy, and cleanliness.
6. To train in the exactness of thought.
7. To acquaint pupils with the occupational opportunities in the field of drafting.

B. Equipment for six pupils

6 Drawing boards (12" x 17")	@	$ .50	$ 3.00
6 T-Squares	@	.35	2.10
3 30° x 60° triangles (No. 10)	@	.35	1.05
3 45° triangles (No. 8)	@	.30	.90
6 sets of mechanical drawing instruments	@	3.50	21.00

The work may be done at a group activity table constructed especially for drawing or it may be done at individual drawing tables. The cost, of course, will vary with the type of facilities provided.

A fairly good quality of individual table may be purchased for twenty dollars ($20.00) each or they might be made in the school shop, in which case the only cost would be for the materials used.

C. Supplies

It is best for individual pupils to provide their own supplies which are not expensive. These supplies should include:

One dozen thumb tacks	5c
One 2H pencil	10c
One HB pencil	10c
One good quality pencil eraser	10c
One cleaner eraser	10c

Drawing paper should be purchased by the pupil as needed. A cheap grade of paper can be used, however, that will cost only about one cent or one and one-half cents a sheet size 10" x 14" and either buff or green would be most desirable.

D. Operations or skills

The things a boy should be able to do are:

1. Fasten the drawing paper on the drawing board.
2. Sharpen a drawing pencil.
3. Measure with the scale.
4. Mark points with a pencil.
5. Choose the neecessary views of an object.
6. Plan a drawing and make a layout of the sheet.
7. Sketch lines and make a working-sketch.
8. Use the T-square and pencils in drawing horizontal lines.
9. Use the T-square and triangles in drawing vertical lines and lines making common angles with the horizontal.
10. Use the triangles to draw lines parallel to other lines.
11. Clean and care for drawing instruments.
12. Keep the drawing and drawing table neat and orderly.
13. Draw, and know when to use, the different kinds of lines required in drafting.
14. Erase pencil lines.
15. Block out views.
16. Make all six views of a rectangular block, showing the correct position of each view in its respective plane of projection.
17. Make a front view and top view, and know the relationship of these views.
18. Make a front view and side view, and know the relationship of these views.

19. Make three views, and know the relationship of these views.
20. Pencil a drawing in correct order.
21. Draw views with hidden edges.
22. Dimension a drawing.
23. Sharpen and adjust a compass lead.
24. Use the pencil compass.
25. Make arrowheads.
26. Make numerals.
27. Lay out a title.
28. Letter upper case letters.
29. Make a drawing to scale.
30. Check a drawing.
31. Draw sectional views of an object, and know when they are required.
32. Make an auxiliary view.
33. Letter notes and specifications.
34. Transfer measurements with the dividers.
35. Divide a line into a given number of equal parts with the dividers.
36. Draw an irregular curve with the French curve.
37. Draw a floor plan.
38. Make six views, showing each view in its correct relationship to each of the other views.
39. Draw isometric axes.
40. Draw non-isometric lines.
41. Draw an isometric square.
42. Draw an isometric circle.
43. Bisect a given angle.
44. Draw an angle similar to a given angle.
45. Construct a square having one side given.
46. To construct an equilateral triangle having one side given.
47. To draw a hexagon having one side given.
48. To draw a hexagon having the long diameter given.
49. To draw an octagon having the the short diameter given.
50. To draw an octagon having the long diameter given.
51. Draw a circle through three given points not in the same straight line.
52. Inscribe a square within a given circle.
53. Inscribe an equilateral triangle within a circle.
54. Draw an ellipse.
55. Draw an arc tangent to two lines not parallel.
56. Bisect an arc.
57. Measure with inside and outside calipers.
58. Determine the true length of a line.
59. Make a blue print.
60. Make a pie graph or chart.
61. Make a square chart.
62. Make a circle chart.
63. Make a bar graph.
64. Make a curve graph.
65. Make a per cent graph or chart.
66. Make a box or diagram graph or chart.
67. Draw bolts with conventional threads.
68. Draw machine parts showing finish, drilled, reamed, and tapped holes.
68. Draw machine parts showing keys and keyways.
69. Draw the development of a square, prism-shaped object.
70. Draw the development of a cone-shaped object.
71. Draw the development of a hexagonal prism cut by an oblique plane.
72. Draw the development of a pyramid-shaped object.
73. Draw the development of a cylinder cut by an oblique plane.
74. Make a detail drawing.
75. Make an assembly drawing.
76. Make a tracing on paper.
77. Determine the line of intersection between two intersecting prisms and develop the surfaces.
78. Determine the line of intersection between two intersecting cylinders and develop the surfaces.
79. Make an oblique drawing.
80. Make a cabinet drawing.

E. Information

The things a boy should know are:

1. The kinds of scales used in measuring, and for what classes of work each is used.
2. The names and uses of drafting instruments, and how to care for them.
3. The sizes of triangles and T-squares, and how designated.
4. How to select and care for a drawing board.

5. How to arrange the lighting in order to protect the eyes.

6. When to use various types of drawing to the best advantage.

7. The importance and value of mechanical drawing in its relation to industry.

8. The benefit secured from a study of mechanical drawing.

9. When to use the various kinds of lines used in drafting (sometimes called the alphabet of lines).

10. Be familiar with the most important of the conventional procedures and practices used in drafting.

11. The various factors that enter into the making of a good drawing and the relative importance of each.

12. The correct spelling, meaning, and application of the most important and most frequently used words and terms in the field of drafting.

13. Know the fundamental principles of orthographic projection and be able to apply them.

14. The correct procedure in making an isometric drawing involving isometric lines, non-isometric lines, and circles.

15. The kinds of pencils best suited for various types of work.

16. The advantages of various types of graphs.

17. Occupational information, including success factors, income, and opportunities.

F. Organization and procedure

"Mechanical drawing," as the name implies, "is that form of drawing which enables a designer or draftsman to secure exactness of line and dimensions with the use of various mechanical instruments. It is the process of representing graphically upon paper, by the means of views, the shape, size, and description of any desired object, or it may indicate the relation of the different parts of an object one to another. A drawing does not always represent a real object; it may represent some visionary object that one desires to make a reality."[7] It is in reality a mathematical subject and in its application is closely related to the field of engineering.

Mechanical drawing has always been recognized as one of the most important subjects taught within the field of industrial arts. Although the practices and conventional procedures in the field of drafting have changed from time to time; the relation between the drafting taught as a part of the industrial arts course and the various industrial subjects or activities has not changed. In other words, mechanical drawing must continue (as it has in the past) to be closely related to the industrial (shop) activities.

This relationship is not a mere theoretical relationship; but is a counterpart of the situation in industry, wherein the industrial arts finds its cue to all established customs and practices.

The major development within the field of mechanical drawing during recent years has been an increase in the scope or content. This has brought about added emphasis on free-hand sketching and includes also a study of the principles of design and their application, and stresses to a greater extent the more practical phases of the subject for all pupils. A few leaders in the industrial arts field advocate calling the course "Drawing and Planning" instead of mechanical drawing, in view of the change in content and shift in emphasis.

Mechanical drawing should be a valuable subject for two very definite and specific reasons: first, for its general educational value; second, for its exploratory value in the field of graphic art.

The general educational value has been placed first because of the fact that we are living in an industrial and a mechanical age. The writers believe in the theory that one of the major functions of education should be to acquaint the pupil with the environment in which he will live.

The growth and development of industry has been one of the outstanding achievements of this country since the Civil War. This tremendous industrial development has affected the lives of all individuals in the country, and it will continue to affect the lives of each succeeding generation, even to a far greater extent, as industries continue to grow and develop.

If this is true, then, why is it not essential for the schools to assume the responsi-

[7] Thurman C. Crook, *Simplified Mechanical Drawing* (Peoria, Illinois: Manual Arts Press), 1928, Introduction.

bility for acquainting the future generation to some extent, with the nature of the environment in which he will live?

Yet, all this did not develop in mere accidental fashion. It grew and developed first in the form of sketches, plans, and drawings. As this is being written the American China Clipper Ship is winging its way over the last stretches of the Pacific Ocean on its trail-blazing journey to the Orient. Yet, only a short time ago this mistress of the air was only a drawing on the drafting board of the designer. What a thrill it must be to the designer and the draftsman to see this marvelous piece of mechanism making history day after day.

As a result of this development the layman finds a far greater and wider use for drawing today than was true a few generations ago.

Mechanical drawing is the language of industry. It is the universal language of the mechanical and industrial world—the medium of expression whereby one mechanic talks to another, or whereby a designer or draftsman conveys his ideas to the mechanic.

A short unit course in mechanical drawing extending over a period of nine to eighteen weeks should serve to help pupils determine for themselves the extent to which they possess the necessary characteristics and qualifications (aptitudes and capacities) for success in the graphic art. The teacher, of course, will serve a valuable function in directing the pupil's exploratory experience and also in helping him interpret the results.

The work in drawing may be organized on the basis of either the logical or psychological approach. In the logical approach (which has been most frequently used) objectives are set up for the course and then specific problems are selected that seem to best attain these objectives. These problems are usually abstract problems or exercises, graded according to difficulty and each is to be drawn by the pupil in the order presented.

The second or psychological approach has recently been advocated with much vigor by a few leaders in the industrial arts field. In this plan the drawing course and the problems therein develop as an extension of the pupils' interest. The teacher first makes an analysis of the interests of each individual pupil, then groups them in such a way that there will likely be from three to six groups. The teacher and the pupils in each group then select the problems that are to be completed by the pupils in the various groups. The problems are selected with a definite consideration of the apparent interest of each pupil.

The writers feel obligated at this point to evaluate rather briefly these two plans or methods of selecting and presenting the content of mechanical drawing courses.

The logical method permits the teacher to set up the objectives of the course and organize the work in accordance with the objectives. The course can then include, in sequential and graded order, problems that will permit the teacher to attain the objectives set up for the course.

The writers desire to emphasize this fact in connection with an evaluation of the logical approach: the interest of the pupil does not need to be entirely eliminated or ignored as a factor in the organization of the course. According to this plan, the teacher considers first the objectives to be attained and then selects the problems in accordance with these objectives, keeping in mind at all times the possible interest of the pupil in the work being planned.

In the psychological approach the interest of the pupil is practically the only guide the teacher has in selecting the work to be completed. He cannot set up specific objectives with hardly more than a gambler's chance of attaining them because of the fact that he does not know and cannot know in advance the exact nature of the pupils' interest. This forces the teacher to plan a course in accordance with a variable factor which is usually difficult to determine.

If the pupil apparently has no initial interest which will serve as a point of departure, the teacher is forced to develop for that pupil a course following the logical method. It would not stand to reason that the teacher would allow such a pupil to "mark time" waiting for some interest to develop.

Then suppose the pupil loses interest. The teacher at this point is confronted with the problem of developing or stimulating an interest in the pupil in the work to be done.

Assuming that this can be done, at this time, why cannot it also be done to an acceptable degree in the logical method.

In the final analysis it might be said that there is no logical method of organization in teaching mechanical drawing apart from the psychological, and neither is there a psychological approach to be thought of apart from the logical.

The teacher can check on the achievement and progress of the class much easier when using the logical approach. In the psychological method the "check-up" cannot be made apart from the pupils' interest and of course that is a variable factor.

In view of the fact that a short unit course in beginning mechanical drawing should not place undue emphasis on any one phase of the subject, the writers would like to recommend that the following units be included:

Order	Units	No. of Drawings
1	Alphabet of lines	1
2	Lettering (upper case only)	1
3	Use of instruments	
4	Geometric construction	6 to 10
5	Orthographic projection	5 to 8
6	Free hand sketching	4 to 8
7	Working drawings	4 to 8
8	Graphs	4 to 7
9	Pictorial drawing	4 to 8
10	Development	3 to 6
11	Machine drawing	3 to 6
12	Intersections	2 to 4

The units might be taken up in the order given above, or the order can be changed somewhat in accordance with the objectives set up in the method to be used.

The number of drawings included in each unit will also vary under diffferent conditions, even though the general objectives may be the same. The number of drawings recommended for each unit are stated above.

G. A suggested form of new-type tests for mechanical drawing (pairing or matching terms in parallel columns)

Instruction for pupils: Write the proper numbers from column A in the blanks in front of colum B.

Example: See Number 1 below

A	B
1. Helix	5 Pencil
2. Blue Print	———— Dimensions
3. Sectional View	———— Thread
4. Working Drawing	———— Cutting plane
5. 2H	———— Language of Industry
6. Mechanical Drawing	———— Tracing Paper

Number Correct————

Number Incorrect————

Name of Pupil Score ————

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VII. ORGANIZATION OF WORK IN CONCRETE

A. Aims

1. To acquaint the pupils with a product that is playing an increasingly important part in the industrial world today.

2. To give the pupils some knowledge of the various concrete mixtures and possible use of each.

3. To study the most important of the many types of concrete work.

4. To give the pupils some experience in selection of materials, mixing, placing, finishing, and curing of concrete for various uses.

5. To conduct a few simple experiments that will enable the pupils to understand proper methods of curing, proper selection, washing, and grading of aggregates, methods and principles of reinforcing, design and control of mixing, placing and workability, strength, bleaching, and waterproofing.

6. To acquaint the pupils with accepted practices and procedures in estimating materials for various types of concrete work.

7. To study the history and manufacture of cement.

8. To acquaint the pupils with the extent to which cement and concrete are used today.

9. To study a few of the more easily understood research studies that have been made in the field of cement and concrete.

10. To make sure the pupil understands all the factors that enter into the production of durable concrete work for a few of the most common types of jobs, and the ex-

tent to which each of these factors can be controlled.

11. To acquaint the pupils with the nature and extent of the work in concrete which they can do around their own homes.

12. To study the occupational opportunities of the various fields of cement and concrete work.

B. Equipment

The equipment for a course in concrete work need not be elaborate or expensive. As a matter of fact, a very large part of it may be made in the school shop.

The following is a suggestive list of equipment for six pupils. The quotations are only approximate and are for a medium grade of equipment.

No.	Item		Approximate Unit Cost	Total Cost
3	No. 2, square-edge D-handle shovels	@	$1.50	$ 4.50
1	Wheelbarrow, 3 cu. ft. capacity	@	7.00	7.00
3	Pointing trowels (either 5″ or 6″ blade)	@	.50	1.50
12	*Tamps, assorted sizes			1.00
8	*Wood floats with handles, assorted shapes			.50
1	*Sand screen, ¼″ mesh (18″ x 36″)	@	.50	.50
1	Draining spade 5½″ x 4⅜″ Blade, 12″ long	@	1.75	1.75
3	Plasterer's steel finishing trowels	@	1.50	4.50
1	*Sand screen, ¾″ mesh (18″ x 36″)	@	.50	.50
1	*Sand bin, to hold at least 1 cu. yd.	@	4.00	4.00
1	Ten-quart hand sprinkler	@	1.00	1.00
2	Ten-quart pails	@	.25	.50
1	*Mixing platform, 5′ x 8′	@	5.00	5.00
1	*Truck with small wheels, 2′ x 3½′	@	3.00	3.00
2	Edgers 6″ x 3″, ⅜″ radius	@	.75	1.50
2	Groovers 6″ x 3″, with one straight end	@	.75	1.50
1	Mason's trowel	@	1.50	1.50
1	Level	@	2.00	2.00
1	Small metal tamp	@	1.25	1.25
3	*Measuring boxes, ½, 1, 2 cu. ft. capacity			.65
2	Wire brushes	@	.65	1.30
1	Water tub for curing small projects	@	3.00	3.00
1	lot *quarter-sawed oak for a dozen or more forms of a variety of designs of several projects			16.00
	Sheet metal for covering the cores of the forms			2.00

* Can be made in the shop.

Such tools as hammer, pliers, screw driver, hatchet, cold chisel, etc., will likely be found in most school shops, but if not they may be purchased for approximately $5.00.

The forms will constitute the most expensive part of the equipment. It is quite possible to make a variety of wood forms which are satisfactory, but they wear out and are not so desirable as the metal forms.

If the forms are to be made in the school shop, they should be constructed of quarter-sawed hard wood (oak is satisfactory) and soaked in raw linseed oil thinned with turpentine for about ten days. The cores can be "boxed up" and covered with metal.

If the forms are to be made in the school shop the approximate cost of the necessary equipment, as specified in the foregoing, will be seventy-one dollars.

If metal forms are to be used, it would be well to have forms for about four projects to start with and others can be added at a later date. The forms given below are suggested:

Rustic junior square colorcrete flower box, approximate cost	$20.00
Colorcrete bird bath form, approximate cost	75.00
Woodmere senior jardiniere form, approximate cost	40.00
Rustic senior colorcrete flower box, approximate cost	28.00

Even though the metal forms are used, it would be desirable to supplement the

range of possible projects by making wooden forms for a few additional pieces. The total cost of the equipment as specified, including the four metal forms, is approximately $234.00.

C. Supplies

Sand and cement will be the most bulky of the necessary supplies, but they do not have to be purchased in large quantities.

The variety of the work attempted will, of course, determine the nature of the materials needed. For example, if color work is to be included, fifteen to twenty pounds of mineral mortar color will be needed for each of the colors desired.

If space is limited the work may be limited to the use of selected aggregates (marble and granite) which may be purchased in bags and in a variety of colors.

The cost of materials will, of course, vary a great deal in different localities.

1 cu. yd. fine plastering sand			$2.00
1 cu. yd. ⅝″ down washed gravel			2.00
12 bags gray cement	@	$ .80	9.60
2 bags white cement	@	2.00	4.00
40 lb. mortar color	@	.20	8.00
4 cu. ft. marble chips (aggregate)	@	1.25	5.00
2 pieces 3/8″ round soft steel 16″ long	@	.30	.60
10 ft. galvanized hardware cloth ½″ mesh, 30″ wide			1.50

D. Operations

The things a boy should be able to do are:

1. Make a drawing for a simple form.
2. Select materials for forms.
3. Make out a bill of materials for forms.
4. Make simple wood forms.
5. Estimate materials for such jobs as walks, foundations, floors, etc.
6. Make out a bill of materials for simple concrete projects and jobs.
7. Proportion materials for maximum strength.
8. Measure materials.
9. Mix concrete materials by hand method, both dry and wet mix.
10. Make the following items of equipment: measuring box, mixing platform, tamps, spading tool; forms for such projects as stepping stones, baseball home-plate, ash trays, book ends, chimney cap; wood floats, sand screen.
11. Set forms in place.
12. Make forms secure.
13. Place concrete in forms.
14. Tamp concrete materials.
15. Spade concrete materials.
16. Level with straight-edge or strike-board.
17. Lay out foundation or floor.
18. Finish concrete surfaces with steel trowel, wood float, brush, burlap pad, scrub-finish, rubbed surfaces, tooled surfaces.
19. Apply water-cement wash.
20. Rub selected aggregate surfaces with sandstone.
21. Color concrete by using mortar colors.
22. Oil wood forms.
23. Cure concrete work.
24. Protect new concrete.
25. Test aggregate for cleanliness.
26. Wash aggregate.
27. Sift or screen aggregate.
28. Grade aggregates.
29. Use groover.
30. Use edger.
31. Wash concrete with acid.
32. Select, cut, and bend reinforcing materials.
33. Place reinforcing materials.
34. Excavate for foundations, footings, floors, etc.
35. Block out surfaces (as in sidewalks and floors).
36. Bond new concrete to old.
37. Place footings, sub-base, or foundations.
38. Remove forms from foundations, walks, floors, etc.
39. Remove wood and steel forms from ornamental projects.
40. How to use add-mixtures.

E. Information

The things a boy should know are:

1. Names of the tools most frequently used in cement and concrete work.
2. The effect of rapid drying on cement and concrete.
3. The time required for setting and curing.
4. The principal causes of failure in concrete and how to overcome them.

5. How to estimate the materials needed for a job.
6. How concrete is tested.
7. The principal materials used for forms.
8. The purpose of add-mixtures.
9. When and how to use add-mixtures.
10. How to make concrete waterproof.
11. The chemical reaction of cement in forming concrete.
12. How cement is manufactured.
13. The extent of the use of concrete today.
14. How aggregates are washed and graded.
15. How to calculate the weight and strength of concrete.
16. How to make simple tests.
17. Geological classification of aggregates.
18. How to clean and care for forms.
19. The importance of the water-cement ratio in making good concrete.
20. The provisions of the local building code that relate to concrete work.
21. The history and development of modern cement.
22. The early history of cement and the extent of its use.
23. The location of centers for the manufacture of cement.
24. The unit cost of common types of concrete work, such as walks, floors, etc.
25. The contribution concrete makes to our present healthful living condition.
26. Occupational information concerning the cement and concrete industry.
27. The factors and conditions that determine the strength of concrete.
28. The various types of reinforcing and where they are used.
29. How to place reinforcing.
30. What is meant by the setting of cement (initial set and final set).
31. The extent to which variation in the size of aggregate affects the strength of concrete.
32. The effect of freezing on concrete.
33. The important requirements for a good concrete aggregate.
34. The meaning of the terms "consistency," "plastic," and "workability" as applied to concrete mixtures.
35. Method of determining free or surface water carried by aggregates.
36. How the curing of the concrete affects the "watertightness" of the cement paste.
37. The relative effect of additions of fine and course aggregates.
38. The general nature and extent of the research that has been in progress in the field of cement and concrete work.
39. Who discovered modern cement.
40. The size of fine and coarse aggregate.
41. The effect of voids in concrete.
42. The government specification for fineness of cement.
43. Why clean beach sand should not be used in concrete work.
44. The effect of pressure on strength of concrete.
45. How to make "sawable" concrete.
46. The extent of the use of concrete around the home and on the farm.
47. The mixtures recommended for various types or classes of concrete work.

F. List of suggestive projects

Projects that can be made in the school shop are:

1. Home plate for baseball.
2. Concrete dish for bulbs.
3. Test blocks for experimental work.
4. Concrete flagstones for garden walk.
5. Base for vaulting or jumping standards.
6. Well curb (can be used for flower beds).
7. Concrete tile for fireplace hearth.
8. Window sills for brick veneer house.
9. Head stone for grave.
10. Postal card plaque.
11. Lamp base and post.
12. Ornamental base for Christmas tree.
13. Chimney cap.
14. Shoe scraper.
15. Book ends.
16. Lamp base.
17. Porch column caps.
18. Lawn or garden bench.
19. Concrete blocks.
20. Concrete bricks.
21. Anchor weights.
22. Concrete posts.
23. Paper weights.
24. Lawn roller.

25. Cistern tops.
26. Bird house.
27. Door stop.
28. Tea tile.
29. Tamper.
30. Flower box.
31. Jardiniere.
32. Bird bath.
33. Pedestal.
34. Urn.
35. Sun dial.
36. Ash trays.
37. Pin trays.
38. Number plate for house.
39. Clock.
40. Flagstaff base.

B. Projects that will have to be made "on the job"

1. Ornamental rock pedestal for garden.
2. Ornamental rock flower bed.
3. Block for laundry stove in basement.
4. Walk.
5. Steps.
6. Ash pit.
7. Trash receptacle and refuse burner.
8. Short driveway.
9. Auto washing floor.
10. Simple lawn fountain.
11. Feeding floor.
12. Manure pit.
13. Concrete trough.
14. Garage floor.
15. Garage foundation.
16. Sand box.
17. Curb.
18. Drain.
19. Hot bed.
20. Repair work.
21. Well top.
22. Dog house.
23. Lily pond.
24. Duck pond.
25. Wading pool.
26. Engine base.

Such projects as book ends, ash trays, door stops, and other small projects of this type can be made with a very little equipment, and are not expensive even though the materials from which they are made cost more than the material for the usual type of concrete work.

The fact that there is available a great volume of free material in the field of concrete affords the teacher a splendid opportunity to include in the course a considerable study of related subjects.

The work in concrete should include, if at all possible, at least one group project done "on the job." A short walk, a garage foundation, a garage floor, an ash pit, a short drive-way, or some other job of this type affords the teacher an unusual opportunity to provide a splendid experience for his class entirely outside the range of the usual shop experience.

G. A suggested form of new-type tests for concrete (single-choice form of recognition type)

Instructions for pupils: Underline the word or phrase that makes the best or truest answer.

Example: The best material for use in reinforcing concrete is:
(1) aluminum; (2) cast iron; (3) wire; (4) steel

1. The best finish for a concrete walk can be secured by using a:
(1) steel trowel; (2) wooden float; (3) brush; (4) drag belt.
2. The deterioration of cement in storage is caused by: (1) absorption of atmospheric moisture; (2) length of time in storage; (3) change in temeperature; (4) pressure due to stacking of bags.
3. The slump test is an effective measure of : (1) consistency; (2) density; (3) workability; (4) displacement.
4. What water-cement ratio can be used with assurance that the concrete will be water tight: (1) 4 to 6 gal. per sack; (2) 5 to 7 gal. per sack; (3) 6 to 8 gal. per sack; (4) 7 to 9 gal. per sack.

Name of pupil

Number correct_____
Number incorrect_____
Score _____

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Hool, George A., and Harry E. Pulver, *Concrete Practice.* New York: McGraw-Hill Book Company, 1926. 369 pp.

Popular Mechanics Concrete Handbook. Chicago: The Popular Mechanics Press, 1929. 110 pp.

I. Free material for concrete

Alpha Portland Cement Company, Battle Creek, Michigan
"Alpha Cement, How To Use It"
"Alpha Cement, Old Homes Made New"
"High Early Strength Concrete"

"American Society of Civil Engineers Highway Research In Illinois"

Atlas Portland Cement Company, 25 Broadway, New York City, New York
"Atlas Portland Cement for Concrete"

Experiment Station, Kansas State College, Topeka, Kansas
"The Durability of Concrete," by C. H. Scholar, Bulletin Mp/28
"Volume Change of Concrete," by C. H. Scholar and E. R. Dawley, Bulletin No. 25, 1931

Lehigh Portland Cement Company, Chicago, Illinois
"The Lehigh Farm Book of Structographs"

Portland Cement Association, Chicago, Illinois.
"A Practical Course in Concrete"
"A Third of a Century of Progress in the Manufacture of Portland Cement"
"Cement is the Magic of Concrete"
"Permanent Farm Construction"
"Seeing Concrete America"
"Vocational Course in Concrete"

Portland Cement Association, Indianapolis, Indiana
"Cold Weather Construction With Concrete Masonry"
"Concrete Around the Home"
"Concrete Data for Engineers and Architects"
"Concrete Fence Posts"
"Concrete Floor"
"Concrete Floor Finishes"
"Concrete Masonry Construction"
"Concrete Masonry Construction for Enduring and Firesafe Structures"
"Concrete Pavement Construction in Hot Weather"
"Concrete Sidewalks"
"Concrete Tanks, Troughs, and Cisterns"
"Foundation Walls and Basements of Concrete"
"101 Farm Uses of Concrete"
"Performance Under Fire"
"Permanent Repairs on the Farm"
"Recommended Practice for Building Watertight Basements With Concrete"
"Safe Sewage Disposal"
"The Essential of Earthquake-proof Construction"

Portland Cement Association, New York City, New York
"Concrete Improvements Around the Home"
"Design and Control of Concrete Mixtures"
"High Lights on the Portland Cement Industry"
"Stucco Surfacing"

Portland Cement Company, Easton, Pennsylvania
"The Manufacture of Portland Cement"

Star Cement Company, Greencastle, Indiana
"Picturing the Manufacture of Cement"

U. S. Department of Agriculture, Farmers' Bulletin No. 1480, May, 1926
"Small Concrete Construction on the Farm"

Universal Portland Cement Company, Chicago, Illinois
"Concrete Pavements, Sidewalks, Curbs and Gutter"
"Universal the Magic Powder"

Wellston Iron Furnace Company, Jackson, Ohio
"Permanency in Construction"

VIII. Organization of Work in Bench Metal Work

A. Aims

1. Reveal the skill, patience, and perseverance required in working steel in the cold state, thereby affording the pupils an opportunity to discover their interests, abilities, and aptitudes.

2. Develop acquaintance with materials, tools, and processes utilized in the making of machines which will be of value to a consumer and which will create an appreciation of metal working industries.

3. Reveal the occupational opportunities afforded by the machinist's trade which may lead the student to find his niche in the social order, or, if not carried on vocationally, provide avocational and leisure time activity.

4. Make the sciences, mathematics, history, geography, art, and mechanical drawing more vital in pupils' everyday lives.

5. Develop initiative, safety consciousness, leadership, character, followership, a respect for manual labor, and confidence in ability to do things.

B. Equipment to accommodate six pupils and cost of same

	Estimated Cost
Work bench 48" x 10" with 6 drawers (home made)	$15.00
Sensitive drill press with ½" capacity drill chuck	60.00
6 machinists vises 4" jaws, solid bases @ $8.00	48.00
6 sets of tools as follows to be kept in bench drawers	17.70
a. One 10" double cut flat file .10	
b. One center punch .10	
c. One scratch awl . 10	
d. One one-pound ball peen hammer .60	
e. One 5" spring divider .90	
f. One 6" steel rule or scale .90	
g. One 8" screw driver .25	
A wall board or cabinet about 36" x 44" (home made)	3.00
A set of tools as follows to be kept on the wall board or in cabinet	
a. Straight shank drills No. 21, 3/16", 13/64", 7/32" 27/64", ⅜", 7/16", ¼" ½"	1.00
b. Threading taps 10-32 machine screw	.15
c. Threading dies 10-32 machine screw	.75
d. Hand taps ½" —13 U. S. S. thread	.50
e. Threading die ½"—13 U. S. S. thread	2.00
f. Hand reamers ½" and ¾" diameters	5.00
g. 2 hack saws @ $1.00	2.00
h. 2 monkey wrenches 10" @ $1.50	3.00
i. Curling jug (I. S. T. C.)	2.00
j. Emery cloth (per quire)	1.50
k. Blue Vitriol, 2 oz.	.25
l. Polishing wheel 6"diameter	1.00
m. Tripoli, one brick	.40
n. 1 oil can	.15
o. 1 oil pan (tin can)	.00
p. Lead blocks on which to beat sheet metal (home made) @ .50	.50
1 twelve-inch combination set	3.75
1 one-inch micrometer	3.50
1 five-inch spring caliper outside	.90
1 five-inch spring caliper inside	.90

C. Supplies and cost of same	Estimated Cost
5 bars ⅛" x 1" soft steel (angle bracket)	$ .90
5 bars ⅛" x ¾" soft steel (angle bracket)	.75
2 bars ⅛" x 1½" soft steel(foot scraper) (pinchers)	.53
10 bars 3/16" x ½" soft steel (flower pot stand)	3.00
5 bars ¼" square soft steel (camp grate)	.70
2 bars 316" square soft steel	
2 3/16"x¾" cold rolled steel (hack saw)	.40
1 bar ½"x 2" cold rolled steel ("C" clamp) (marking guage)	3.00
2 bars ⅝" square cold rolled steel (parallel clamps)	3.00
2 bars ⅝" x 1½" soft steel (alligator wrench) (tap and die wrench)	3.00
1 bar 1" round soft steel (camp grate)	1.00
1 bar ¾" square annealed tool steel (hammer)	3.00
10 lbs. 16 guage sheet iron(garden trowel)	.50
10 lbs. old scrap saw blade (dividers)	.00
2 bars ⅜" round cold rolled (hack saw)	.65
1 bar ½" round cold rolled (vice)	.50
1 bar ¾" hexagon cold rolled (screw driver) (plumb bob)	1.00
1 bar 1" round cold rolled (vice)	1.60
18 paper weight castings	1.00
10 vice castings	3.00
8 junk pistons 4" diameter, ¾" pin hole (grinder)	.40
18 alumninum pistons (ash trays)	3.60
16 work arbors (grinder)	4.00

32 brass bushing ¾" outside ½" hole (grinder) 4.80
36 ¾" wrought washers (divider) .36
10 No. 2 lutz file handles (hack saw) 1.50
18 ¾" x ¾" thumb screws (marking gauge)
2 lbs. 3/16" x ⅜" round head rivets .30
2 lbs. ¼" x 1⅜" round head rivets .30
1 box 10" x 32" x 1" round head machine screws .35
1 box 10" x 32" x 1" flat head machine screws .35
Note: The steel may be stored under the bench.

D. Operations

The things a boy should be able to do are:

1. Read blue prints.
2. Use instruction sheets.
3. Choose stock.
4. Measure with steel rule or scale.
5. Use hand hack saw.
6. Lay out a hole for drilling.
7. Mount drills in a drill press.
8. Drill holes to a layout.
9. Use a cutting lubricant.
10. Drill holes to be tapped.
11. Tap holes.
12. Use try square.
13. File surface straight and square.
14. Countersink.
15. Grind a cold chisel.
16. Use threading die.
17. Drill holes in a second piece using first piece as a template.
18. Rivet.
19. File ends square.
20. Use breast drill.
21. Use electric drill.
22. Twist flat steel.
23. Bend flat steel.
24. Use tin snips.
25. Shift belts.
26. Draw filing.
27. Grind tools.
28. Use hand drill.
29. Grind a twist drill.
30. File corners round.
31. Cut rivets.
32. Use hand reamer.
33. Use drilling jig.
34. Cut sheet iron to shape using a chisel.
35. Act as shop foreman.
36. Use bevel protractor in bending.
37. Repair simple machines.
38. Use bending jig.
39. Ream.
40. Chip to a line.
41. File ends semi-circular.
42. Sharpen knives.
43. School repair jobs.
44. Lay out a casting for chipping.
45. Assemble machines.
46. Inspect.
47. Lace belts.
48. Sharpen axes, shovels, picks, etc.
49. Soldering.
50. Babbitt bearings.
51. Replace leather in a pump.
52. Sharpen lawn mower.
53. File keys.
54. Clean and adjust oil stove.
55. Pipe fitting.
56. Paint metal work.
57. Dismantle a gas engine.
58. Repair a door lock.
59. Adjust steam radiators.
60. Cover steam pipes and boilers.

E. Information

The things a boy should know are:

1. What a modern machine shop consists of.
2. Rules of safety and the use of safety appliances.
3. How to read blue prints.
4. Names of tools.
5. Shop terms.
6. How to read instruction sheets and use of same.
7. Proper care and use of tools and accessories.
8. First aid treatment in accident cases.
9. How to measure with steel scale.
10. Machine shop machine tools.
11. Names of machine parts.
12. Saws and sawing.
13. Files and filing.
14. Drills and drilling.
15. Taps and tapping.
16. Machinists vises and care of same.
17. How to oil machines.
18. Speed and feed for drilling.
19. How to measure with outside calipers.
20. Iron and steel.
21. Occupational possibilities of machine shop work.
22. How to find proper tap drill to use.
23. Oils and cutting lubricants.
24. Occupational information.

25. How to read a micrometer.
26. Emery wheels and grinding.
27. Screws, bolts, rivets, screw rivets, taper pins, keys, pipe fittings.
28. How to change fractions to a decimal and vice versa.
29. Adding, substracting, and dividing fractions by the aid of a steel rule or scale.
30. Screw threads.
31. Materials used in machine building.
32. How to calculate tap drill sizes.
33. Related science.
34. Reamers and reaming.
35. Belts and belt lacings.
36. A study of general mechanical principles as they apply to all machines.
37. How materials are obtained.
38. Pulley speed.
39. Form in which materials are used.
40. Bearing metals.
41. Pitch and lead of screw threads.
42. Spark test for different kinds of iron and steel.
43. Recognizing metals by eye sight.
44. Circumferences, areas, and volumes.
45. Calculating tapers per foot and corresponding angles and vice versa.
46. Estimating cost of work.
47. A history of the lathe.
48. A study of a wheel and axle.
49. A study of levers.
50. A study of the screw and wedge.
51. Gearing problems.
52. How machines are sold.
53. How to read gas, water, and electric meters.
54. Use and care of paint and lacquer brushes.
55. Study of gas engines.
56. A seven place manufacturing scheme.
57. Steam boiler studies .
58. A prony brake test to determine the effect of speed upon horse power.
59. Drill jigs.
60. Transmission of power by means of belts and shafting.
61. Where materials are found.
62. Copper alloys.
63. Aluminum.

F. Projects

A list of projects for machine shop practice is given in rank order herewith. These rankings were made by industrial arts teachers.

Rank	Project
1	Hack-saw frame
2	Nail set
3	Ball peen hammer
4	Hexagon hollow handle screw driver
5	"C" clamp
6.5	Tinners hammer (small size cross peen)
	Ball peen hammer
8	Marking gauge
9	Parallel clamp
10	"T" handle tap wrench
11	Tap and die wrench
12	Calipers
13	Pocket scriber
14	Bolt and nut
15	Lathe center
16	Angle brackets (wrought iron)
17	Foot scraper (wrought iron)
18	Flower pot stand (wrought iron)
19	Table lamp (wrought iron)
20	Graden trowel
21	Dividers
22	Home-made jig saw
23	Lathe mandrel
24	Corner irons (wrought iron)
25	Machinist's vise
26	Plumb-bob
27	Camp grate
28	Luggage carrier
29	Home-made wood turning lathe
30	Floor lamp (wrought iron)
31	Bell centering punch
32	Anvil paper weight
33	Mercury plum-bob
34	Candle holder (wrought iron)
35	Gear blanks
36.5	Polishing head planer jack
	Planer jack
38	Home made drill press
39	Roaster for weiners
40	Sink scraper
41.5	Plug gauge
	Knife
43.5	Home made saw table
	Wheel and gear puller
45	Drill gauge
46	Alligator wrench
47	Jack screw
48	Hose reel
49	Jeweler's vise (wrought iron)
50	Combination wrench
51.5	Jardiniere stand
	Footstool
53	Pinchers
54	End table
55	Auto spring opener
56	Magazine stand
57	Auto jack
58	Home made shaper for wood
59	Radio bench
60	Water power grinder
61	Book rack
62	Grinder
63	Carpenter's vise
64	Piano bench

65 Pliers
66 Drill chuck
67 Steam engine
68 Soldering iron furnace

Colvin, Fred H., and Frank A. Stanley, *American Machinist Handbook*. New York: McGraw-Hill Book Company, 1932. 1135 pp.

G. Tests—General information test (matching)

Bench Metal Work

This is a test of general information of elementary machine shop practice. Read the directions carefully.

Sheet No. 1 Part 1

Directions: At the bottom of the page are words and phrases bearing letters. In the blank spaces of the statements on the upper par of the sheet you are to place the letter which represents the word or phrase that will make each statement correct. Example:

Lathe tools are made of B

Correct _____
False _____
Score _____

1. Steel that is rolled accurately to size is called_____
   A. Soft steel
   B. Tool steel
   C. Heat treated
   D. Low weight
   E. Cold rolled steel
   F. Spark test
   (Et cetra)

H. Bibliography

1. Textbooks for the pupil

Burghardt, Henry D., *Machine Tool Operation, Part I*. New York: McGraw-Hill Book Company, 1919. 362 pp.

Jones, Harry A., *Progressive Lessons in Machine Shop Practice, Book I*. Peoria, Illinois: The Manual Arts Press, 1926. 172 pp.

Kaup, William J., *Machine Shop Practice*. New York: John Wiley and Sons, 1914. 199 pp.

Palmateer, T. J., *Elementary Machine Shop Practice*. Peoria, Illinois: The Manual Arts Press, 1920. 123 pp.

Peterson, L. C., *101 Metal Working Projects* Milwaukee: The Bruce Publishing Company, 1929. 214 pp.

Smith, Robert H., *Elements of Machine Work*. Boston: Industrial Education Book Company, 1910. 192 pp.

Van Leuven, Edwin Perry.*Cold Metal Working*. New York: McGraw-Hill Book Company, 1931. 275 pp.

2. Reference books for the teacher

Berg, Edward, and Bristol E. Wing, *Essentials of Metal Working*. Peoria, Illinois: The Manual Arts Press, 1927. 159 pp.

Breckenridge, William E., Samuel F. Mersereau and Charles F. Moore, *Shop Probblems in Mathematics*. Chicago: Ginn and Company, 1916. 280 pp.

Eaton, Joseph J. and Albert V. Free, *Machine Shop Science*. Peoria, Illinois: The Manual Arts Press, 1926. 181 pp.

Johnson, James F., *Shop Mechanics and Mathematics*. New York: John Wiley and Sons, 1926. 130 pp.

Smith, Albert W., *Materials of Machines*. New York: John Wiley and Sons, 1914. 215 pp.

3. Free Material

American Steel and Wire Company, 208 South LaSalle Street, Chicago, Illinois
"Manual of Wire for Manufacturing Purposes"
"How Steel and Steel Wire Products are Made"
"American Wire Rope"
"Elevator Wire Ropes and Electrical Cables"
"Flat Wire Bulletin No. 2"
"Adaptability of Flat Wire in Manufacture"
"The Experiences of an Atom"

American Sheet and Tin Plate Company, Pittsburgh, Pennsylvania
"The Age of Alloys"
"The Protection of Steel Sheets Against Rusting"
"Steel Sheets"
"U. S. S. Stainless Steels"

Aluminum Company of America, Pittsburgh, Pennsylvania

"Aluminum Casting Alloys"
"Aluminum"
"Alcon Aluminum and Its Alloys"
"The Riveting of Aluminum"

Behr-Manning Corporation, Troy, New York
"How to Sharpen"
"The Difference Book"
"Abrasive Papers and Cloths for the Student and Home Craftsman"

Brown and Sharpe Manufacturing Company, Providence, Rhode Island
"How to Read and Use Micrometer Calipers"
"The Micrometer"

Cleveland Twist Drill Company, 1242 East 49th Street, Cleveland, Ohio
"Handbook for Drillers"

E. C. Atkins Company, 402 South Illinois Street, Indianapolis, Indiana
"Atkins Grinding Wheels"
"Atkins Mill Saws"
"Atkins AAA Hack Saw Blades"
"Atkins Silver Steel Hack Saw"

Morse Twist Drill and Machine Company, New Bedford, Massachusetts
"Machinists' Practical Guide"

The Carborundum Company, Niagara Falls, New York
"The Romance of Carborundum"
"Abrasives in the Service of Industry" by E. J. Tone
"Carborundum Wheels and Blocks"

Norton Company, Worchester, Massachusetts
"Grits and Grinds"
"Grinding Wheel Information"
"Research and Alundum Polishing Grains"
"What to Specify"
"Artificial Abrasives"
"Bricks and Sticks"
"Grinding Wheel Selection"
"Grinding Wheel Specifications"
"Character and Uses of North Products"
"Tool and Cutter Grinding"

Pike Manufacturing Company, Pike, New Hampshire
"Sharpening Stones: History and Development"

Vacuum Oil Company, New York City, New York
"Correct Lubrication of Machinery"

Socony Vacuum Oil Company, New York City, New York
"Lubricants and Coolants for Metal Cutting"
"Grooving Oil-lubricated Cylindrical Bearings"

The L. S. Starret Company, Athol, Massachusetts
"The Starrett Data Book for Machinists" Vol. II
"The Starrett Book for Machinists' Apprentices"

Racine Tool and Machine Company, Racine, Wisconsin
"The Right Saw for the Purpose"

J. T. Ryerson and Sons, Inc., Chicago, Illinois
"Ryerson Handbook on Tool and Alloy Steels"

Nicholson File Company, Providence, Rhode Island
"File Filosophy"

U. S. Department of Commerce, Bureau of Standards, Washington, D. C.
"Grinding Wheels"

The Lodge and Shipley Machine Tool Company, Cincinnati, Ohio
"200 Years Ago"
"The Evolution of the Lathe"

IX. Organization of Work in Foundry Practice

A. Aims

1. To reveal the skill of hand and degree of judgment required in the making of sand molds, thereby affording the pupils an opportunity to discover their interests, abilities, and aptitudes in this respect.

2. To develop acquaintance with the metals that are cast into shape, with the tools and processes employed, and with the possibilities of alloying metals.

3. To reveal the occupational opportunities afforded by the molder's trade which may lead the student to find his niche in the social order, or, if not carried on vocationally, provide avocational and leisure time activity.

4. To make the sciences, mathematics, history, geography, and art more vital in pupils' everyday lives.

5. To develop initiative, safety consciousness, leadership, character, followership, a respect for manual labor, and confidence in ability to do things.

B. Equipment to accommodate six pupils and cost of same

		Estimated Cost
1 sand bin (Make your own)		
2 yards of brass molding sand	@ $3.00	$ 6.00
1 aluminum melting furnace		75.00
a. Gas furnace		75.00
b. Coke furnace		33.00
c. Oil furnace		75.00
d. Plumber's melting furnace (gasoline)		8.50
Note: A home made furnace or forge may be used and if lead is poured it may be melted on a gas plate in a ladle.		
Steel flasks		
a. 3-10″ x 3″ cope and 3″ drag	@ $3.00	9.00
b. 3-10″ x 5″ cope 5″ drag	@ $3.00	9.00
c. 3-12″ x 12″ x 4″ cope and 4″ drag	@ $3.00	9.00
Note: Home made flasks may be used.		
Molding boards and bottom boards may be made		.15
3 sets of bench molder's tools consisting of:		
a. Round nose finishing trowel 5″		.50
b. Spoon and oval slick (Use a common spoon)		.30
c. Yankee lifter ½″		.30
d. Draw spike (Scrap) steel 5/16″ square		.05
e. Rapping bar (Scrap steel ½″ round)		.05
f. Vent rod (Old umbrella rib)		.00
g. Gate cutter (Piece of tin)		.00
h. Sponge		.05
i. Bellows 10″		.75
j. Riddle brass No. 8		.70
k. Rammer (Make your own)		.50
l. Flat bladed shovel		.60
m. Strike off (Make your own)		.00
n. Sack for parting (Make your own)		.00
o. Soft hair brush		.50
p. Sack for plumbago (Make your own)		.00
q. A box for tools 5″x10″x12″ (Make your own)		.50
1 sprinkling can		.50
Sprue pins (Make your own)		.00
Flask weights to hold cope down (Use old rails)		.75
2 No. 16 crucibles	@ $1.92	3.84
1 crucible tong (Make your own)		.25
1 crucible shank (Make your own)		.25
1 skimming bar (Make your own)		.10
1 can for flux (A tin can)		.00
6 pairs of goggles	@ $1.90	11.40
6 pairs of leggings	@ .75	4.50
Mineral Exhibit (Wards Natural Science Establishment, Rochester, New York)		11.05
1 grinder stand (Use machine shop)		.00
1 wire wheel brush 6″ diameter x 1″ thickness		2.00
1 canvas polishing wheel		1.50
Hack saw and files (Use machine shop)		.00
3 single pick up tongs 18″ handles		.60
Machinist' vise 4″ jaws (Use machine shop)		.00
One-ton coke bin (if coke is used)		15.00
1 Kitchen scale of 25 lbs. capacity		1.00
1 bin for storing metal (make your own)		15.00
1 locker for storing tools((Make your own)		15.00

C. Supplies and cost of same

Scrap aluminum, brass, lead, or type metal may be used satisfactorily. Under certain conditions, however, it will be as cheap to buy ingot metal from a brass foundry and this will be far more satisfactory for school use.

200 lbs. of brass or lead (ingot,	@ 12c)	24.00
100 lbs. of aluminum (ingot,	@ 21c)	21.00
Brass flux, 5 lbs	@ 35c	1.75
Aluminum flux, 5 lbs.	@ 75c	3.75
Commercial parting 25 lbs.	@ 7c	1.75
Plumbago, 10 lbs.	@ 6½c	.65
Powdered emery, No. 60 5 lbs.	@ 15c	.75
Tripoli polishing brick		.60
Foundry coke, one ton		9.00

D. Operations

The things a boys should be able to do are:

1. Riddle and temper the sand.
2. Choose a flask to suit the pattern.
3. Place the pattern in position on the mold board.
4. Ram the drag.
5. Level up bottom board.
6. Roll drag over.
7. Make parting.
8. Place sprue pin and ram the cope.
9. Strike off and form pouring basin.
10. Remove the cope.

11. Draw the pattern.
12. Cut the gate.
13. Replace the cope on the drag.
14. Set mold in position on pouring floor.
15. Weigh and clamp molds.
16. Furnace operation.
17. Melt the metal and flux it.
18. Pour the molds and skim the metal.
19. Break open the molds and remove sprues and gates.
20. Tumble the castings.
21. Put the shop in order.
22. Grind and polish the castings.
23. Apply different kinds of finishes to the castings.
24. Determining causes of failures and decide on how to prevent a repetition of same.
25. Core making.
26. Mold a baked core pattern.
27. Mold a green sand core pattern.
28. Mold a split pattern.
29. Mold thin patterns.
30. Mold irregular parting patterns.
31. Bed in a pattern or raise the drag.
32. Mold a gated pattern.
33. Mold a pattern requiring a three part flask.
34. Use risers.
35. Use cross-bars.
36. Use chaplets.
37. Use gaggers.
38. Use soldiers.
39. Use facing material.
40. Use upsets.
41. Use articles made of glass, celluloid, etc., as patterns.
42. Use follow boards and match plates.
43. Mold brass tablets and school emblems.
44. Make metal patterns.
45. Mold a plate which is to be thinner than the pattern.
46. Mold a plate which is to be thicker than the pattern.
47. Mold unusual or freak patterns.
48. Act as shop foreman.
49. Calculate amount of metal required to pour molds.
50. Operate the gas furnace.
51. Operate the coke fired furnace.
52. Operate the oil burning furnace.
53. Keep a record of heat.

E. Information

The things a boy should know are:

1. Rules of safety and the use of safety applicances.
2. Tools used.
3. Materials used.
4. Metals used.
5. How to read instruction sheets and use same.
6. First aid treatment in accident cases.
7. What constitutes good molding sand.
8. How to read blue prints.
9. Care of machinery and tools used.
10. Draft.
11. Split patterns.
12. Loose piece patterns.
13. Cored patterns.
14. Properties of facings.
15. Core binders.
16. Shrinkage.
17. Care of crucibles.
18. Furnaces and cupolas for melting metals.
19. Cupola operation.
20. The use of finished articles as patterns.
21. Pressure in molds.
22. Specific gravity of metals and woods.
23. Estimating weight of casting from pattern.
24. Occupational possibilities of foundry practice.
25. Molding as a part of engineering.
26. Branches of the foundry industry.
27. Estimating the cost of doing work.
28. Alloys and alloying metals.
29. Properties of fluxes.
30. Effect of silicon, sulphur, phosphorous, and manganese on castings.
31. The production of metals.
32. Principles of feeding molds.
33. Properties of core binders.
34. Emery wheels, grinding and polishing machines.
35. Metal pattern making.
36. Wood carving as an aid to pattern-making.
37. Clay modeling as aid to pattern-making.
38. Statuary casting.
39. Bell casting.
40. Designing and making patterns.
41. The use of particles made of glass and celluloid as patterns.

42. Coke and coke making.
43. History of molding.
44. Malleable iron molding.
45. Steel casting.
46. Permanent mold casting.
47. Ornamental molding.
48. Core making machines.
49. Labor saving devices.
50. Pattern letters and figures.
51. The use of a chill in a mold.
52. Acetylene, electric, and thermit welding.
53. Electro-plating.

F. Projects

1. Patterns having flat backs.
   a. Simple rectangular blocks.
   b. Book ends.
   c. Paper weight.
   d. House numbers.
   e. Door stops.
   f. Angle plates.
   g. Ship mantel piece.
   h. Plaques.
   i. Name plates.
   j. Door knockers.
   k. Base castings.
   l. Lodge emblems.
   m. Hot plate.
2. Patterns cast partly in both cope and drag.
   a. Ash trays.
   b. Pin trays.
   c. Door knockers.
   d. Envelope openers.
   e. Flat iron stand.
   f. Bases for lamps.
3. Split patterns.
   a. Candle holders.
   b. Toy animals.
   c. Table lamps.
   d. Dumb bells.
   e. Toy engines.
4. Thin patterns.
   a. Plaques.
   b. Visiting card plate.
   c. Sun dial.
   d. Skillet.
   e. Fruit plate.
5. Irregular parting patterns.
   a. Desk sets.
   b. Parts of table lamps and floor lamps.
   c. Pulleys.
   d. Gnomon for sun dial.
   e. Spoked wheels.
   f. Window fastener for flag.
6. Farm castings.
   a. Ladles.
   b. Knife handles.
   c. Skillets.
   d. Parts of machines.
   e. Hot plates.
   f. Spoons.
   g. Artificial hen eggs.
7. Green sand core patterns.
   a. Waffle irons.
   b. Frying pan.
   c. Ladles.
   d. Corn bread plate.
   e. Door knockers.
   f. Base for waffle iron.
   g. Bowls.
   h. Soap dishes.
   i. Pie plates.
   j. Scoop shovels.
   k. Dinner bells.
8. Baked core patterns.
   a. Candle holders.
   b. Bodies of electric lamps.
   c. Napkin rings.
   d. Sleigh bells.
9. Boy Scout equipment.
   a. Flag stand.
   b. Skillet.
   c. Ladle.
10. Home mechanics.
    a. Kitchen utensils.
    b. Auto parts.
    c. Plumbing fixtures.

G. Tests: Essay Type Completion Test in Elementary Foundry Work

In this test there are one hundred missing words. You are to write the proper word or words in the blank spaces.

Correct ————————
Incorrect ————————
Score ————————

Example: The proper words for number one space are sand molds
Foundry practice consists in making Sand molds and filling them with————————
(Et cetera) ———————— 2

1

H. Bibliography

1. Textbooks for the pupil

International Correspondence School, *Instruction Papers.* Scranton, Pennsylvania: International Textbook Company. 42 to 164 pp.

Lewis, Melvin S. and John H. Dillon, *Instruction Sheets for the General Shop, Foundry.* New York: McGraw-Hill Book Company, 1932. 177 pp.

Richards, William A., *Elementary Foundry Practice.* New York: The Macmillan Company, 1912. 121 pp.

Stimpson, William C., Burton L. Gray, and John Grennan, *Foundry Work.* Chicago: American Technical Society, 1932. 202 pp.

Wendt, R. E., *Foundry Work.* New York: McGraw-Hill Book Company, 1928. 206 pp.

2. Reference books for the teacher

Buchanan, John F., *Practical Alloying.* Cleveland: The Penton Publishing Company, 1920. 205 pp.

Hartley, Lawrence A., *Elementary Foundry Technology.* New York: McGraw-Hill Book Company, 128. 423 pp.

Moldenke, Richard, *The Principles of Iron Founding.* New York: McGraw-Hill Book Company, 1930. 654 pp.

3. Free Material

Naugatuch Crucible Company, 2525 Clybourne Avenue, Chicago, Illinois
"Crucibles, Their Care and Use"

R. W. McIlvaine Company, 53 West Jackson Boulevard, Chicago, Illinois
"Sand Moisture at a Glance"

J. Dixon Crucible Company, Jersey City, New Jersey
"Prolonging the Life of a Crucible"
"Crucibles: Their Care and Use"

International Nickel Company, 67 Wall Street, New York City New York
"Five Minutes With Monel Metal"

Copper and Brass Research Association, 25 Broadway, New York City, New York
"Coloring Copper and Brass"

Aluminum Cooking Utensils Company, New Kensington, Pennsylvania
"The Aluminum Age"

E. C. Atkins Company, 402 South Illinois Street, Indianapolis, Indiana
"Atkins Grinding Wheels"
"Atkins Mill Saws"
"Atkins AAA Hack Saw Blades"
"Atkins Silver Steel Hack Saw"

Malleable Iron Research Institute Inc., Union Trust Building, Cleveland, Ohio
"Certified Malleable Iron"

The Carborundum Company, Niagara Falls, New York
"The Romance of Carborundum"
"Abbrasives in the Service of Industry" by E. J. Tone.
"Carborundum Wheels and Blocks"

G. H. Smith Steel Casting Company, Milwaukee, Wisconsin
"The Story of Smith Company Steel Castings"

X. Teaching Aids

Teaching aids are an essential part of a general shop course of study. The following aids may be suggested under this title, namely: check lists, shop foreman duties, attendance record and progress charts, instruction sheets. The samples given are for illustrative purposes. Similar ones may be worked out for any shop activity and drawing.

1. Check list of what you should know:

The following is a list of what you should know about foundry practice by the end of the course. You as asked to check (√) each item as you feel able to answer it. It should serve as a self-examination.

Item	Check here
a. Rules of safety and the use of safety appliances	
b. The materials used	
c. Draft as it relates to patterns	
d. Split patterns and why they are split	
e. The tools used	
(Et cetera)	

2. Check list of what you should be able to do:

Item	Check here
a. Riddle and temper the sand	
b. Ram the drag	
c. Cut the gate	
d. Choose the flask to suit the pattern	
e. Vent the cope	
(Et cetera)	

3. Check list of what you should be:

The following is a list of desirable attitudes and habits which will contribute to

your success in life. Only *you* can develop them, and you should consciously practice them until they become habits.[5]

I. *Industry.* This means a habit of careful, thoughtful work, without loitering or wasting time.

II. *Cooperation.* This means an attitude of readiness to assist others when they need help, and to join in group undertakings.

III. *Consideration of others.* This means a thoughtful attitude in the matter of making things easy and pleasant for others, such as keeping things in order, putting tools away in good condition, and always doing your full share of work where others are involved.

IV. *Self-reliance.* This attitude is a very important factor in success. It means that you should develop the habit of planning your tasks carefully and thoughtfully, and carrying them out with the least possible assistance. Be sure the problem is too difficult for you before you call for help.

V. *Readiness to assume responsibility.* This means that you should not refuse to undertake a task because it is difficult, and when once undertaken you should carry it through to completion.

4. Duties of shop foreman

a. Prevent accidents to pupils and to equipment
b. Help interpret instruction sheets
c. Assist in use of tools and equipment
d. See that instruction sheets are used as they are intended to be used
e. Melt the metal and when it is ready to pour notify the instructor
f. See that shop is put in order
   Put patterns and tools away
   Clean shovels and hang them up
   Also riddles
   Close sand bin and brush up floor
g. In all things, take instructor's place or call him

5. Daily attendance record and progress chart

It is suggested that a chart as illustrated be made for each activity. These charts should be hung on the wall so that each student can see the progress that he is making in comparison with his schoolmates. Each pupil should be given credit for what he does each day whether the work be done on a project, studying an information or operation sheet, filling out a job sheet, acting as a shop foreman or as the librarian. In the space under each student's name and in line with the day is entered the work he starts on. At the end of the period he is given a grade on the day's work. This is shown under John Doe, Monday, (paper weight B). The "B" stands for average work. The "red B" indicates that the work was completed. "A" means above average, "B" means average, and "C" means below average.

6. Instruction Sheets

a. The term "instruction sheet is interpreted as a broad term embodying the job sheet, information sheet, operation sheet, etc. The job sheet is interpreted as a sheet which provides explicit instruction in completing a specified job. The information sheet is interpreted as a sheet which provides information relative to doing the work. Information sheets may be divided into two classes, related technical information sheets and general related information sheets. Related technical inofrmation sheets are those that provide specific information relative to doing a specific job. General related information sheets are those that provide information of a general nature. The operation sheet is interpreted as a sheet which provides instruction in performing a specific operation.

[5]This list will apply to all industrial arts subjects and is taken from the American Vocational Association Bulletin, entitled "Standards of Attainment in Industrial Arts Teaching," December 7, 1934.

b. Sample job sheet

Bench Metal Work

Job Sheet No.——— Grade 9

To Make an Alligator Wrench

(A drawing of the project should appear here)

Started——— Date ——— Hour Finished——— Date ——— Hour Total time———

General Information

(This information should be helpful in the making of the project)

Materials

	Cost
	Weight per lb. Total

Tools

Procedure

1. Study the drawing and form a mental picture of the object
2. Choose the stock required
3. Saw it to length

(Et cetera)

Questions

1. What is an alligator wrench used for?

(Et cetera)

References

1.
2.

Bench Metal Work

Information Sheet No.——— Grade 9

How to Recognize Different Kinds of Metal Used in Machine Building

1. Soft steel, low carbon steel, and machine steel are different teims used for the same material.
2.
3.

(Et cetera)

Questions

1.
2.
3.

References

1.
2.

Bench Metal Work

Operation Sheet No.——— Grade 9

To Lay Out a Hole for Drilling

1. Study the blue print and discover the exact location for the center of the hole.
2. (Et cetera)

Questions

1. What is chalk used for in layout work?
2. (Et cetera)

References

1.
2.

Foundry Practice — DAILY ATTENDANCE RECORD AND PROGRESS CHART — 1st Semester, 1934

Weeks	Days	John Doe	William Smith	George Brown	Harry Jones	Oscar Olson	James Hamilton	Weeks	Days	John Doe	William Smith	George Brown	Harry Jones	Oscar Olsson	James Hamilton
1	Mon.							4	Mon.						
	Tues.								Tues.						
	Wed.								Wed.						
	Thurs.								Thurs.						
	Fri.								Fri.						
2	Mon.							5	Mon.						
	Tues.								Tues.						
	Wed.								Wed.						
	Thurs.								Thurs.						
	Fri.								Fri.						
3	Mon.							6	Mon.						
	Tues.								Tues.						
	Wed.								Wed.						
	Thurs.								Thurs.						
	Fri.								Fri.						

Fri.

Fri.